



Europäisches Patentamt  
European Patent Office  
Office européen des brevets

(11) Publication number:

0 034 493

A2

(12)

## EUROPEAN PATENT APPLICATION

(21) Application number: 81300621.0

(51) Int. Cl.<sup>3</sup>: F 16 L 19/08

(22) Date of filing: 16.02.81

(30) Priority: 19.02.80 US 122211

(71) Applicant: GOULD INC.  
10 Gould Center  
Rolling Meadows Illinois 60008(US)

(43) Date of publication of application:  
26.08.81 Bulletin 81/34

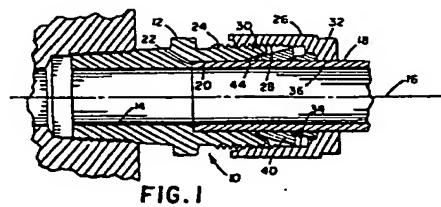
(72) Inventor: Schwarz, Albert J.  
7232 North Keystone Avenue  
Lincolnwood Illinois 60646(US)

(84) Designated Contracting States:  
BE DE FR GB IT NL SE

(74) Representative: Milhench, Howard Leslie et al,  
A.A. Thornton & Co. Northumberland House 303/306  
High Holborn  
London, WC1V 7LE(GB)

### (54) Tube coupling with frangible sleeve.

(57) A conduit coupling is provided having a body member with an axial bore which is adapted to receive the end of a conduit. A fastening member also includes an axial bore and is adapted to surround the conduit and be secured to the body member. A sleeve having an axial bore is also adapted to surround the conduit and is axially positioned between the fastening member and the body member. The sleeve includes a frangible web for separating the sleeve into a plurality of elements in response to the application of an axially compressive force on the sleeve. Once the sleeve is separated, the plurality of sleeve elements cooperate with the fastening member and the body member to create a mechanically strong fluid-tight joint between the body member and the conduit.



A2  
EP 0 034 493

CD-7123

-1-

## TUBE COUPLING WITH FRANGIBLE SLEEVE

BACKGROUND OF THE INVENTION

This invention relates generally to tube fittings and particularly to fittings for forming a strong fluid-tight joint between straight ended tubes and the fitting body.

- 5        Many types of tube fittings have heretofore been utilized for making a strong, fluid-tight connection between the fitting and the end of a tube of circular cross section. The present invention relates to an improvement in one class of these fittings generally known in the art as "bite-type" or flareless fittings. Such flareless fittings generally include a body member surrounding the end of the tube, a nut which also surrounds the tube and threadingly engages the body member, and one or more ferrules placed in
- 10      15 axial compression between the nut and the body member and forced against the outer wall of the tube in a biting fashion. The ferrules are designed to create both a fluid-tight seal and a strong mechanical grip. An example of such a tube coupling is found in U.S. Patent No. 2,484,815 to Crawford. The coupling shown in the Crawford patent includes two ferrules, one ferrule primarily being utilized to obtain a good fluid-tight seal and a second ferrule primarily employed to obtain a strong mechanical grip between
- 20      25 the coupling and the tube. Although such two ferrule

type fittings have generally worked well, there have been some problems and shortcomings associated with their use. Fittings of this general type are nearly always assembled or made up under field conditions by 5 any one of a large number of technicians, any one of whom may have a relatively limited experience with a particular type of fitting. Thus, as one increases the number of parts in the fitting, as is the case in the two ferrule construction, one greatly increases 10 the probability that the fitting will be improperly assembled. For example, in the type of fitting shown in the above-mentioned Crawford patent, it is possible for one to assemble the ferrules in as many as eight different ways. However, there is only one proper 15 sequence and direction if adequate gripping and sealing is to be obtained.

To overcome the problem of improper assembly, which exists even with single ferrule designs, a number of couplings have been designed in which a sleeve is 20 attached to the nut and fractures during assembly to create both a seal and a mechanical joint. Examples of such couplings appear in U.S. Patent No. 1,889,778 to Dobrick, U.S. Patent No. 3,743,324 to Schwarz, et al. and U.S. Patent No. 4,022,497 to Katsakis. These 25 couplings are generally effective in creating a reasonably strong good sealing joint. However, since couplings of this type result in the utilization of only a single ferrule for both sealing and mechanical strength, they generally do not perform as well as the 30 aforementioned double ferrule design.

Another problem associated with fittings of this general type is the requirement that the biting edges of the ferrules be harder than the tubing to obtain a strong reliable mechanical connection. In

the double ferrule type construction shown in the aforementioned Crawford patent, this requirement would particularly apply to the ferrule adjacent the nut. In certain chemical processes, it may be un-  
5 desirable to have a fitting made of more than one material. For example, if corrosion resistance is required, it may be that the fitting must be made entirely of austenitic stainless steel and be suitable for use with tubing which is made of the same material.  
10 Austenitic stainless steel cannot be hardened by heat treatment, and suffers from a reduction in its corro-  
sion resistance if it is hardened by known case-  
hardening methods; this means that there is no readily available technique for assuring that the biting edges  
15 of the ferrule are harder than the tubing in order to assure a strong connection.

An additional shortcoming of the double ferrule construction is that the cost of manufacturing addi-  
tional parts increases the overall manufacturing costs  
20 of the coupling.

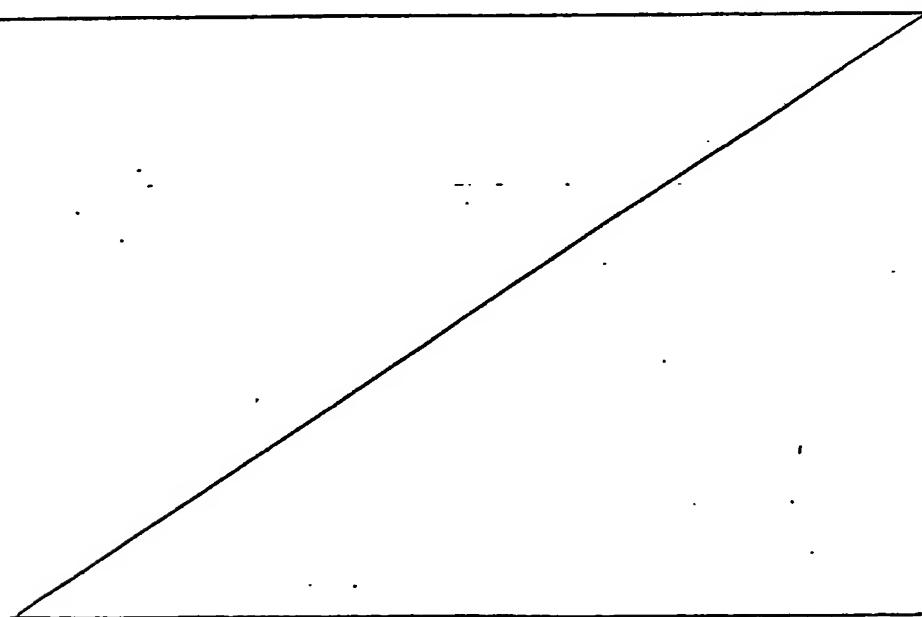
#### SUMMARY OF THE INVENTION

An aspect of the present invention is the provision of a conduit coupling having a body member with an axial bore which is adapted to receive the end of a conduit. A fastening member also includes an axial bore and is adapted to surround the conduit and be secured to the body member. A sleeve having an axial bore is also adapted to surround the conduit and is axially positioned between the fastening mem-  
25 ber and the body member. The sleeve includes at least one frangible web for separating the sleeve into a plurality of elements in response to the application  
30

of an axially compressive force on the sleeve. Once the sleeve is separated, the plurality of sleeve elements cooperate with the fastening member and the body member to create a mechanically strong fluid-tight joint between the body member and the conduit.

Hereinafter described in detail are embodiments of the present invention comprising conduit couplings of the double ferrule type which greatly reduce the opportunity for improper assembly when compared with prior designs, and which may be manufactured of a single uniform material, and less expensively than prior designs. The hereinafter described conduit couplings generally require less torque and fewer turns to assemble than prior designs, and generally create a stronger and better fluid-tight joint than prior designs.

Other features and advantages of the present invention will become apparent from the following detailed description of exemplary embodiments when considered in conjunction with the accompanying drawings.



-5-

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a longitudinal cross-sectional view of the conduit coupling of the present invention in the initial stages of assembly on the end of a  
5 conduit;

FIGURE 2 is an enlarged longitudinal cross-sectional view of the sleeve of the coupling shown in FIGURE 1;

FIGURE 3 is an enlarged view of a portion of  
10 the coupling shown in FIGURE 2;

FIGURE 4 is a longitudinal cross-sectional view of the conduit coupling of the present invention in final assembled form on the end of a conduit;

FIGURE 5 is a longitudinal cross-sectional  
15 view of a second embodiment of the conduit coupling of the present invention in the initial stages of assembly on the end of a conduit; and

FIGURE 6 is a longitudinal cross-sectional view of the conduit coupling shown in FIGURE 5 in  
20 final assembled form.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first preferred embodiment of the present invention will now be described in connection with FIGURES 1 through 4. A conduit coupling generally  
25 shown at 10 includes a body member 12 having a bore 14 extending axially therethrough. The body member 12 is preferably symmetrical about the longitudinal axis 16. The body member 12 is adapted to receive the end of a straight section of conduit or tubing 18.  
30 The axial bore in body member 12 is stepped, in a known

-6-

fashion, to include a bore of wider diameter 20 for receiving the end of tube 18. Thus, the tube 18 can be inserted into bore portion 20 until the end of the tube abuts a shoulder 22 created by the difference in 5 the diameters of the bore 14 and the bore 20. The end of the body member 12 which receives the tube 18 preferably includes a male threaded portion 24 on the outer surface thereof.

A fastening member preferably in the form 10 of a nut 26 has a stepped bore 28 extending axially therethrough. The bore 28 includes a female threaded portion 30 on one end thereof which is adapted to threadingly engage the male threaded portion 24 of body member 12. The threaded portions 24 and 30 serve 15 as the sole means for securing the nut 26 to the body member 12. The nut 26 is also preferably symmetrical about axis 16. It should be understood that the fastening member could be secured to the body member 12 by any known means. The bore 28 is reduced at one end 20 of the nut 26 to form an inclined shoulder 32 and a bore portion of reduced diameter 34. The portion of the bore of smallest diameter 36 is designed to fit about the outside of tube 18. The conduit coupling as thus far described is not novel and, in fact, is 25 very similar to the coupling illustrated in the aforementioned U.S. Patent No. 2,484,815 to Crawford.

The novel and improved features of the present invention all relate to the use of a sleeve 40, shown in detail in FIGURES 2 and 3, having a bore 42 30 extending axially therethrough. The bore 42 is adapted to surround the conduit 18. The bore portion 20 of body member 12 terminates in a frusto-conical portion 44 which forms a flared mouth facing down the outside surface of tube 18. The sleeve 40 is axially

positioned between the surface 44 and the inclined shoulder 32 of nut 26. The sleeve 40 includes a first end 46 having a frusto-conical surface 48 adapted to engage the inclined shoulder 32 of nut 26. The surface 48 is inclined at an angle  $\psi$  with respect to the axis of the sleeve.  $\psi$  in this embodiment is  $75^\circ$ . The sleeve 40 also includes a second end 50, axially opposite the first end 46 which is adapted to engage the frusto-conical surface 44 of body member 12. As will 5 become apparent in the discussion of the operation of the coupling of the present invention, the end 50 is relatively thin-walled and is therefore relatively easy to deflect or deform. Additionally, the surface 48 serves as a camming surface for deforming the end 50 10 radially inwardly as the coupling is assembled. Intermediate the ends of sleeve 40 is a portion 60 having a thickness which is substantially less than the thickness of the remainder of the sleeve. This portion of reduced thickness or web 60 constitutes a particularly 15 novel feature of the sleeve of the present invention since it creates a means for separating the sleeve into a plurality of elements in response to an axially compressive force applied to the sleeve. The web 60 may be best seen in FIGURE 3 and includes a wall portion 62 20 which is substantially perpendicular to the axis 16 of the sleeve and inclined portion 64 connected to the wall portion and defining an exterior acute angle  $\alpha$  therebetween. In this embodiment, the angle  $\alpha$  is  $60^\circ$ . Accordingly, the inclined portion 64 is inclined at 25 30 an angle  $\beta$  with respect to the axis of the sleeve.  $\beta$  in this embodiment is  $30^\circ$ .

For reasons which will become apparent in the ensuing discussion of the operation of the coupling of the present invention, it is a particularly important

feature of this invention that the inclined portions 64 have a significantly greater thickness than the wall portion 62. For example, in a sleeve having a bore one-half inch in diameter, the inclined portion 5 64 could have a thickness on the order of .010 inches and the wall portion 62 could have a thickness on the order of .004 inches. The web 60 has a V-shaped cross-section which is defined by an exterior shear groove 66 and two axially adjacent interior shear grooves 10 68 and 70. It should be understood that the web 60 could be formed utilizing only a single interior shear groove 68. However, as will become apparent from the ensuing discussion of the operation of the subject coupling, the additional interior shear groove 70 provides 15 a means for forming a discontinuous surface on what will become a fractured ferrule. This discontinuous surface is adapted to engage the tube in two places along the length of the tube when the coupling is assembled thereon.

20 The sleeve 40 further includes a tapered external surface 72 adjacent the end 50 for mating with the frusto-conical surface 44 of body member 12. The tapered surface 72 forms an angle  $\gamma$  with the longitudinal axis of the sleeve. The angle  $\gamma$  is preferably 25 on the order of 14 to 15° and more importantly, for reasons discussed later, is significantly less than either the angle  $\beta$  or the angle  $\psi$ . Although the body member, the fastening member and the sleeve of the coupling of the present invention can be made of any 30 known materials, and need not be made of the same material, in the preferred embodiment of the present invention these elements are all made of austinitic stainless steel.

-9-

In assembling the coupling of the present invention, the user merely inserts the end of the tube 18 through the bore 36 in nut 26, through the bore 42 of sleeve 40 and into the bore 20 of body member 12 until the end of the tube abuts shoulder 22. The nut 26 and sleeve 40 are then manually advanced along the tube until the nut 26 begins to threadingly engage the body member 12. The nut may then be manually tightened until the end 50 of sleeve 40 engages the frusto-conical surface 44 of body member 12. At this point, the fitting appears as shown in FIGURE 1.

The nut 26 may then be forcibly torqued creating an axially compressive force on the sleeve 40. As is best seen in FIGURE 4, the axially compressive force on the sleeve 40 causes the web 60 to deform and stretches the web in an axial direction until it fractures. Because the wall portion 62 has a thickness which is considerably less than that of the inclined portion 64, the fracture will occur in the wall portion 62 of web 60. Simultaneously with this axial compression and fracturing of the sleeve, the tapered surface 72 is radially compressed by the frusto-conical surface 44 causing the end 50 of sleeve 40 to sealingly engage and grip the tube at 80.

After the web 60 has fractured, the nut 26 may be further torqued causing the now separated rear sleeve element 82 to cut a double groove in the outer surface of the tube 18 at 84 and 86. As was mentioned earlier, the shearing of wall 62 creates a discontinuous surface along the inner surface of the element 82 which results in this dual engagement and gripping of the tube.

It should be noted that in the initial tightening process before the web fractures that since

-10-

the angle  $\gamma$  is substantially less than either the angle  $\alpha$  or the angle  $\psi$  and since the area of surface contact of the surfaces 72 and 44 is greater than the area of surface contact between the surfaces 48 and 32, the frictional grip between the sleeve 40 and the body 12 will exceed the frictional grip between the sleeve 40 and the nut 26. Accordingly, initially, rotation of the nut will not be transferred to the sleeve 40 and correspondingly will not be transferred to the tube 18. Thus, twisting of the tube is prevented. As was mentioned earlier, the relative steepness of the surface 48 results in a camming action which has a tendency to cam the deformable end 50 radially inwardly as the nut is advanced. Furthermore, should any frictional torsional coupling between the nut 26 and the sleeve 40 be created, a torsional stress will be created in the web 60. This torsional stress in the web 60 will increase the total stress in the web, further assuring that fracturing of the web will occur before the tube 18 can be caused to rotate.

Once the web has fractured, the element 82 is free to rotate with the nut 26 on further torquing of the nut and can act as a thrust washer bearing, thereby reducing the tendency of the nut 26 to transmit torque to the tube 18 in the same manner as would a conventional dual ferrule fitting. Additionally, the wall portion 62 is deformed between the element 82 and the newly formed sealing element 88 and serves to seal the junction between the elements 88 and 82 and the tube 18. The wall portion 64 is deformed radially inwardly by the conical surface of element 88, causing it to block off the space between the element 88 and

the tube 18. This blockage and the associated bite 84 cooperate with the bite 86 to strengthen the tube against failure by shaving or skiving action, so that the strength of the combined bites 84 and 86 is at least equal to that of the deeper single bite which would be produced by a single conventional sleeve. It should be understood that the deformation of the tube and sleeve elements shown in FIGURE 4 is merely an approximation of the appearance of an assembled conduit coupling in accordance with the present invention. In every instance, the degree of deformation and bite will, of course, be slightly different.

In practice, it has been found that a fitting of the type described in FIGURES 1 through 4 seals exceedingly well while also requiring less torque and fewer turns to assemble than most prior fittings.

A second embodiment of the conduit coupling of the present invention will now be described in connection with FIGURES 5 and 6. In couplings for use on relatively small diameter tubing, generally of 3/8" diameter or less, it becomes difficult to cut the interior shear grooves 68 and 70 demonstrated in FIGURE 3 with respect to the first embodiment of this invention. However, it is known that the fluid pressure generated force tending to separate the tube from the fitting is proportional to the cross-sectional area of the tube and thus to the square of the diameter of the tube. Conversely, the holding ability of a fitting is proportional to the length of the gripping member and, therefore, is proportional to the diameter of the tube and not the square of the diameter. Thus, when designing fittings for smaller diameter tubes, proportionally much less gripping power is required

-12-

to obtain the same magnitude of pressure seal.

Accordingly, a simplified version of the present invention is illustrated in FIGURES 5 and 6. A coupling 100 generally includes a body member 102 having an axial bore 104 adapted to receive the end of the small diameter tube 106. A nut 108 threadingly engages the body member 102 in a known fashion. The nut 108 includes a bore 110 for surrounding the tube 106. Once again, the nut 108 and the body member 102 are similar to prior coupling designs and in and of themselves are not novel. The coupling 100 is provided with a sleeve 120 which interacts with the body member 102 and the nut 108 in much the same fashion that the sleeve member 40 interacted with the body member 12 and the nut 26 in the first embodiment of the present invention. The sleeve 120, however, differs from the sleeve 40 in that it includes an external shear groove 122 and no internal shear grooves. The sleeve 120 includes a tapered external surface 124 for mating with a corresponding frusto-conical surface 126 of body member 102. However, in this embodiment, the tapered surface 124 terminates at one end in a cylindrical surface 128. The sleeve 120 has an axial bore 130 which has a generally smooth cylindrical surface, with the exception that it is discontinuous along the end adjacent the body member 102. At this end, an annular notch 132 is cut into the sleeve concentric with the cylindrical surface 128. The notch 132 is sufficiently deep so as to form a cylindrical projection 134 on the end of the sleeve which is sufficiently thin walled so as to be deformed radially inwardly during the assembly of the fitting. A web 136 interconnects the portion of the sleeve adjacent the

-13-

nut to the portion of the sleeve adjacent the body member.

The coupling shown in FIGURES 5 and 6 is assembled in much the same manner as the coupling of 5 the first embodiment of the present invention. As the nut 108 threadingly engages the body member 102, the tapered surface 124 engages the frusto-conical surface 126 of the body member 102 and is deformed radially inwardly. Simultaneously, the projection 10 134 is deformed radially inwardly so that the notch 132 engages and grips the tube 106 in a double biting action at points 138 and 140. This biting action is similar to the double biting action produced by element 82 in FIGURE 4 and produces similar beneficial 15 results. As further torquing is applied to the nut 108, the web 136 fractures under axial compression and the tapered surface 142 is pressed against and deformed by the tube creating a tight friction grip between the newly formed element 144 and the tube 106 at point 146. 20 The web 136 is deformed between the second newly formed element 148 and the element 144 to seal the joint between those two elements. The friction grip between the element 144 and tube 106 gives the coupling some additional axial blow-off resistance under fluid pressure and also 25 isolates the grip at points 138 and 140 from the effects of vibration of the tubing external to the fitting.

Thus, it is apparent that a new conduit coupling has been developed which greatly reduces the opportunity for improper coupling assembly by utilizing only a 30 single sleeve in the assembly process while simultaneously providing a double ferrule type coupling. The coupling of the present invention may be manufactured of a single uniform material and is considerably less expensive to manufacture than conventional double ferrule designs.

-14-

In most instances, the coupling of the present invention requires less torque for assembly than prior designs. Additionally, the coupling of the present invention requires only 1 and 1/2 turns of the nut for assembly, which is less than many prior designs. Thus, overall assembly is easier. All of the above advantages are obtained while the coupling of the present invention also creates a stronger and better fluid-tight joint than most prior designs.

While there have been described what are at present considered to be the preferred embodiments of the present invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein, without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

## CLAIMS:

1. A conduit coupling comprising:  
a body member having a bore extending axially therethrough and adapted to receive an end of a conduit;  
a fastening member having a bore extending  
5 axially therethrough and adapted to surround a conduit, said fastening member and said body member including means for securing said fastening member to said body member; and  
a sleeve having a bore extending axially  
10 therethrough and adapted to surround a conduit, said sleeve being axially positioned between said fastening member and said body member, and said sleeve including means for separating said sleeve into a plurality of elements in response to an axially compressive force  
15 applied to said sleeve whereby said plurality of elements in cooperation with said fastening member and said body member serve to create a mechanically strong fluid-tight joint between said body member and a conduit, when said coupling is assembled on an end of a conduit.
2. A coupling as set forth in Claim 1, wherein said means for separating said sleeve into a plurality of elements includes a portion intermediate the ends of said sleeve having a thickness substantially less than the thickness of the remainder of said sleeve for fracturing said sleeve.
3. A coupling as set forth in Claim 2, wherein said sleeve includes a first end adapted to engage said fastening member and a second end axially opposite said first end and adapted to engage said

- 2 -

5 body member, said portion of reduced diameter comprising a web connecting the portion of said sleeve adjacent said first end to the portion of said sleeve adjacent said second end.

4. A coupling as set forth in Claim 3, wherein said web includes a wall portion substantially perpendicular to the axis of said sleeve, said wall portion connecting said web with the portion of said 5 sleeve adjacent said second end, said web further including an inclined portion connected to said wall portion and defining an exterior acute angle therebetween, the thickness of said inclined portion being substantially greater than the thickness of said wall 10 portion to thereby cause said wall portion to fracture in response to the application of an axially compressive force on said sleeve.

5. A coupling as set forth in Claim 4 wherein the angle between said inclined portion of said web and said wall portion of said web is approximately 60°.

6. A coupling as set forth in Claim 4 or 5 wherein said sleeve includes an exterior shear groove and a pair of axially adjacent interior shear grooves cooperating with said exterior shear groove to define 5 said web.

7. A coupling as set forth in Claim 4 or 5 or 6 wherein said first end of said sleeve includes a surface inclined at a first angle with respect to the longitudinal axis of said sleeve, said second end of

- 3 -

- 5 said sleeve includes a surface inclined at a second angle with respect to said sleeve axis, and said inclined portion of said web is inclined at a third angle with respect to said sleeve axis, said second angle being substantially smaller than either said
- 10 first angle or said third angle.

8. A coupling as set forth in any preceding claim, wherein said means for separating said sleeve into a plurality of elements includes means for forming on one of said elements a discontinuous surface adapted
- 5 to engage a conduit in two places along the length thereof when said coupling is assembled on an end of a conduit.

9. A coupling as defined in any preceding claim, wherein said fastening member is a nut and wherein said means for securing said fastening member to said body member includes threads on said nut and said
- 5 body member to enable said nut to threadingly engage said body member.

10. A coupling as set forth in any preceding claim, wherein said body member, said fastening member, and said sleeve are made of the same material.

11. A coupling as set forth in Claim 10, wherein said material is austinitic stainless steel.

12. A coupling as set forth in Claim 1, wherein said sleeve includes a first end adapted to engage said fastening member and a second end axially opposite said first end and adapted to engage said body

- 4 -

5 member, said sleeve bore having a discontinuous surface adjacent said second end adapted to engage a conduit in two places along the length thereof when said coupling is assembled on an end of a conduit.

13. A coupling as set forth in Claim 12, wherein said second end of said sleeve includes a cylindrical projection adapted to be deformed radially inwardly to engage a conduit when said coupling is  
5 assembled on an end of a conduit.

14. A coupling as set forth in Claim 12 or 13, wherein said means for separating said sleeve into a plurality of elements includes a portion intermediate the ends of said sleeve having a thickness substantially less than the thickness of the remainder of  
5 said sleeve.

15. A coupling as set forth in Claim 14, wherein said portion of reduced diameter comprises a web connecting the portion of said sleeve adjacent said first end to the portion of said sleeve adjacent  
5 said second end.

16. A coupling as set forth in Claim 15, wherein said sleeve includes an exterior shear groove, said shear groove cooperating with said axial bore to define said web.

17. A conduit coupling comprising:  
a body member having a bore extending axially therethrough and adapted to coaxially receive a conduit;

- 5 -

- 5           a fastening member having a bore extending axially therethrough and adapted to coaxially receive a conduit, said fastening member and said body member including means for securing said fastening member to said body member; and
- 10          a sleeve having a bore extending axially therethrough and adapted to surround and coaxially receive a conduit, said sleeve being axially positioned between said fastening member and said body member, said sleeve including means for separating
- 15          said sleeve into a plurality of elements in response to an axially compressive force applied to said sleeve, and further including gripping means arranged to be urged into gripping engagement with a conduit as a further result of said axially compressive force,
- 20          whereby said plurality of elements in cooperation with said fastening member and said body member serve to create a mechanically strong joint between said body member and a conduit, when said coupling is assembled on an end of a conduit.

18. A coupling as set forth in Claim 17, wherein said means for separating said sleeve into a plurality of elements includes means for forming, on one of said elements, a discontinuous surface adapted to engage a conduit in two places along the length thereof to thereby form a part of said gripping means.

19. A coupling as set forth in Claim 17 or 18, wherein said sleeve further includes a deformable portion on said second end and a camming surface on said first end for camming said deformable portion radially inwardly when urged thereagainst to thereby form a part of said gripping means.

1 / 3

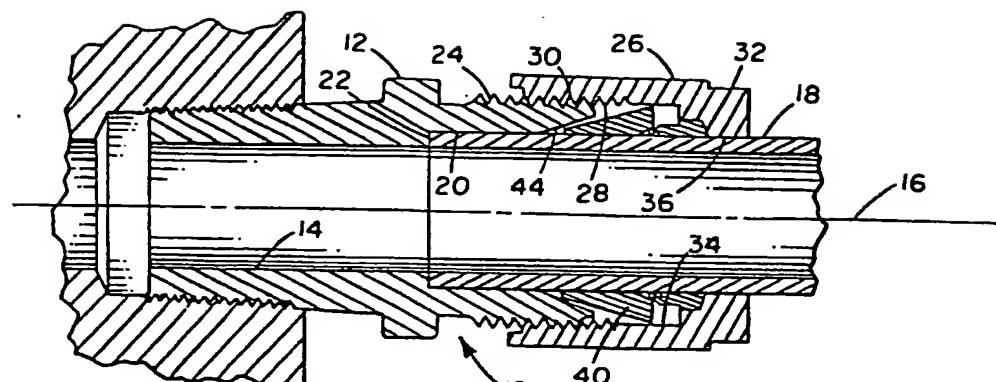


FIG. 1

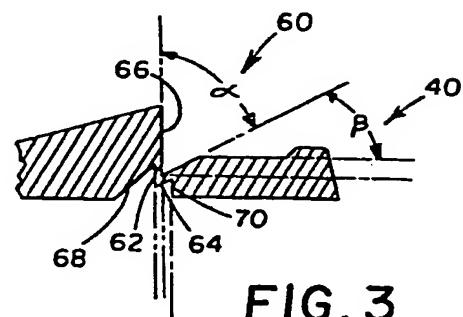


FIG. 3

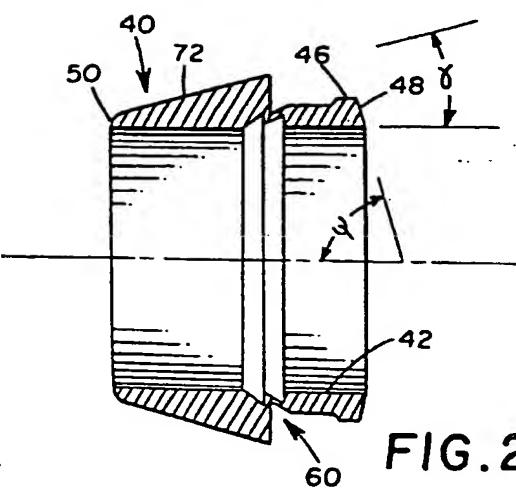


FIG. 2

0034493

2 / 3

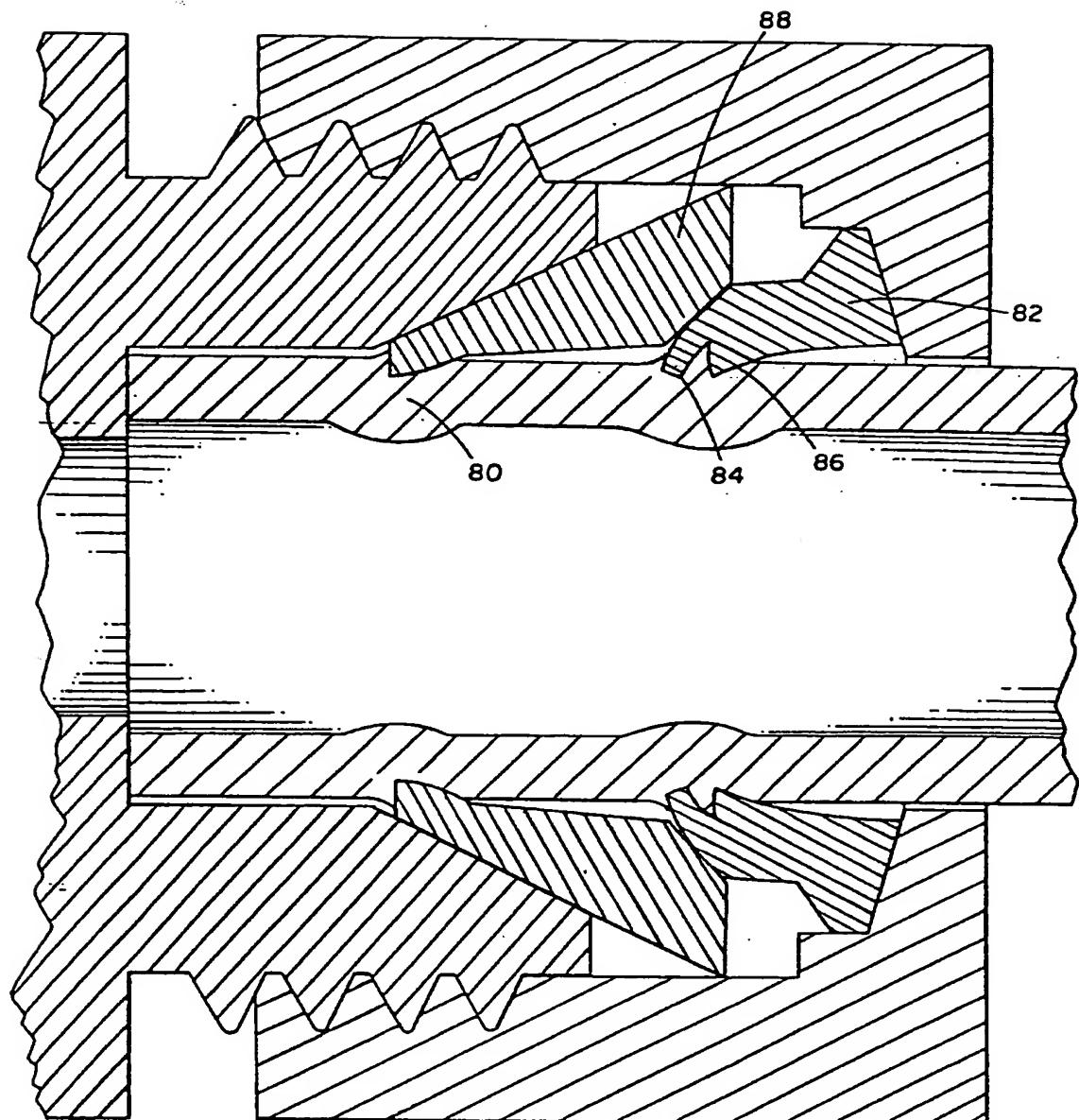


FIG. 4

3 / 3

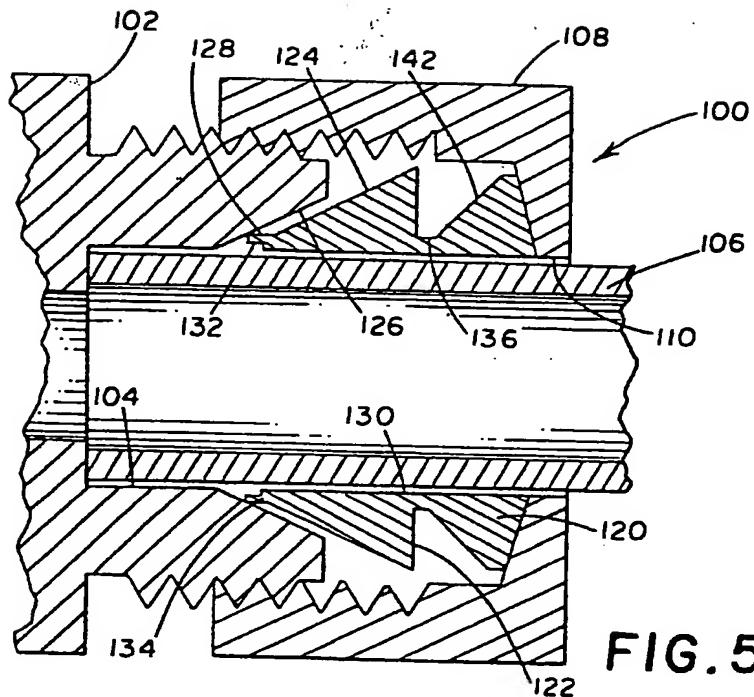


FIG. 5

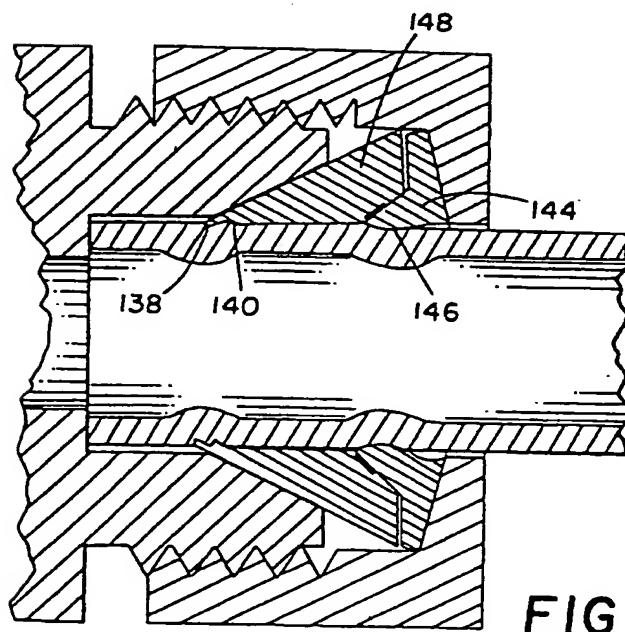


FIG. 6

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record.**

## **BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- BLACK BORDERS**
- IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- FADED TEXT OR DRAWING**
- BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- SKEWED/SLANTED IMAGES**
- COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- GRAY SCALE DOCUMENTS**
- LINES OR MARKS ON ORIGINAL DOCUMENT**
- REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- OTHER:** \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**